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ONION CULTURE

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ONION CULTURE.

INTRODUCTION.

The onion in one or more of its several forms has been in use throughout all time of which we have authentic history. From available records it would appear that the original home of the onion was in southern Asia or in the countries surrounding or bordering on the Mediterranean Sea. During early times the onion was highly esteemed as an article of food, also as a preventive of thirst while on the march or traveling in the desert. In olden times the production of onions was confined to the alluvial river valleys, but the improvement and adaptation of varieties has made it possible to grow this crop under widely diverse conditions.

The onion belongs to the widely variable species *Allium cepa*, which forms a part of a botanical family of plants which includes many of the lilies, the several forms of asparagus and smilax, and similar plants having a scaly or fleshy enlarged root. A characteristic of this family is that most of its species grow naturally upon soil having an abundance of moisture, many of them being natives of low-lying areas along the seashore. Another characteristic of plants like the onion and asparagus is that they will withstand considerable salt in the soils on which they grow. The onion is grown primarily for its bulb; however, the leaves are often employed for seasoning, and there are several kinds that are grown for their leaves only.

Onions are one of the more important of our truck crops, the acreage in the United States during the four years from 1924 to 1927, inclusive, averaging about 70,000. The average yield per acre for this period was about 280 bushels and the total production equaled 41,000 cars of 500 bushels each. The onion is one of the more common crops of our home vegetable gardens, and it is well adapted to growing commercially on a small scale, very little capital being required for a beginning. The market for onions includes practically the entire commercial world, and the demand for a good article continues throughout the entire year.

During recent years the production of both Spanish and Bermuda onions has become firmly established as an industry in the United States. The production of Bermuda onions has developed largely in southwestern Texas, but there are other important producing sec-

tions, and it has been fully demonstrated that the Bermuda onion can be grown over a wide range of territory. The Spanish or Valencia onion is now grown on a large scale in several of the Western States, the quality of the onions produced being practically equal to those imported from Spain.

The object of this bulletin is to give brief information regarding the commercial production of onions, including the history and characteristic features of the Bermuda onion industry in this country. The production of onion seed and sets is restricted to more or less definite localities and for that reason is treated in a separate publication (Farmers' Bulletin 434).

AREAS ADAPTED TO ONION CULTURE.

The onion is exceptional in that it will thrive under a very wide range of climatic and soil conditions. The crop is grown to perfection in the alluvial valley of the Nile River in Egypt, on the volcanic soils and under the tropical sea breezes of the South Sea Islands, along sandy coastal plains, in the irrigated portions of the arid regions, on sandy uplands, and on reclaimed swamp soils. There is perhaps no extended area in the United States, except the mountainous regions, where the onion can not be successfully grown.

CLIMATIC REQUIREMENTS OF THE ONION.

As already noted, the onion will thrive under a wide range of climatic conditions. For best results a temperate climate without great extremes of heat and cold should be selected. Onion culture is rarely profitable in regions where the climate does not change or has no definite seasons of heat and cold or wet and dry. Naturally the onion does best under rather cool conditions, with plenty of moisture during its early stages, but requires a reasonable degree of heat, together with dryness of both soil and atmosphere, for its proper ripening. Where the onion industry has become established in the extreme southern part of the United States, the growing season is during the late autumn and winter, the crop maturing during the spring and early summer. If the crop matures at a time when there is considerable rainfall, it will be impossible to cure the bulbs and they will be lacking in keeping qualities.

Certain types and varieties of onions, including the "top onions" and the "multipliers" or "potato onions," are extremely hardy and may remain in the open ground throughout the winters of our Northern States, especially if given slight protection. These types are, however, not adapted to growing for market, except as green onions, "peelers," or "bunchers," to be sold during the early spring-time. In certain sections of the South Atlantic coast region large

areas of the top and multiplier onions are grown for this purpose. There is also a marked difference in the hardiness of the standard commercial sorts, some being adapted to growing far northward, while others, like the Bermuda, Egyptian, and Spanish types, thrive only in restricted southern localities.

Length of season required for onions.—The period required for the production of a crop of onions will depend upon the season, the methods employed in growing, and the variety. If grown from seed, a period of from one hundred and thirty to one hundred and fifty days will be required. If from sets, the crop may often be matured in one hundred days. If grown in the extreme northern part of the United States, where the seasons are short, the crop will mature more rapidly than to the southward. Onion seed grown in the North will as a rule produce mature bulbs in less time than that produced in a warm climate. In the case of the Bermuda onion, as grown in Texas, the growing season extends from the middle of September to the following March or April.

Rainfall or irrigation.—Onions require an abundance of moisture during the early stages of their growth, but should be ripened under comparatively dry conditions. In most sections the seed is sown at a time of the year when frequent spring rains occur. Their period of greatest growth is during the early part of the summer, and the crop is ripened late in the summer when drying conditions may be expected. In irrigated regions the application of water is almost entirely under the control of the grower. During the active period of growth the water is applied about once a week, the soil being thoroughly soaked and the surplus water drawn off.

The amount of rainfall or irrigation required for the production of a crop of onions will depend largely upon the character of the soil and its drainage. Many of the peat or muck soils in which the soil water remains near the surface will require very little rainfall; in fact, the best crops of onions are produced on these soils during seasons of comparatively light but evenly distributed rainfall. Sandy and loose soils generally will require a greater amount of water, especially during the early part of the season. Excessive rainfall or irrigation will have a tendency to produce onions having a large growth of leaves and stems at the expense of the bulbs. Onions of this character are commonly termed "thick necks" or "scullions."

SOILS ADAPTED TO ONION CULTURE.

The essential requirements of a soil upon which to grow onions profitably are a high state of fertility, good mechanical condition in order that the crop may be easily worked, sufficient drainage, and freedom from weeds. If a soil has the proper mechanical properties—that is, if it contains sufficient sand and humus to be easily

worked, is retentive of moisture and fertilizers, and is capable of drainage—all other requirements can be met. At least three types of soil are being extensively planted to onions in this country, the one common essential being proper mechanical condition.

Clay and alluvial loams.—Soils of this character abound in the river valley and delta regions near the coast. These soils are generally very fertile, but will require the addition of humus or stable manure in order to lighten them. The greatest difficulty encountered in growing onions upon land of this character is the tendency of the soil to run together and bake after hard rains. This is especially injurious after the seed has been sown and before the small plants have attained sufficient size to permit of stirring the soil about them. Where these soils contain considerable sand they are ideal for onion culture. It is upon this class of soil that the greater part of the Bermuda, Spanish, and Egyptian onions are grown.

Sandy loams.—Sandy soils, especially where underlain by a well-drained clay subsoil, are often well adapted to onions. Soils of this character generally require heavy applications of fertilizers before they will produce a paying crop, but the quality of the product is excellent. Onions grown on sandy loams are generally solid, heavy, and of excellent keeping quality. Where sandy soils are lacking in humus this may often be supplied by means of crops of crimson or other clover grown upon the land and plowed under when it has attained its greatest growth. The use of leguminous crops should be supplemented by occasional applications of 1,000 to 1,200 pounds of lime to the acre.

Muck and peat soils.—Throughout the north central part of the United States there are vast tracts of peat or muck soils that are capable of producing onions. Before planting to onions, however, these soils must be cleared, drained, and brought to a suitable state of cultivation. In many cases this process will require two or three years' time, but sometimes the soil can be broken during the early winter, allowed to lie exposed to the action of frost for a few weeks, and planted to onions the following spring. Some of the largest onion farms are located on muck lands, and there are still great tracts of this class of soil waiting to be reclaimed.

The store of plant food in muck soil is usually large, but often it is not in available condition, and heavy applications of manure and commercial fertilizers, such as superphosphate and potash, are essential to profitable crops.

CULTURAL METHODS.

The onion belongs to that class of crops which gives best results under very intensive culture, and the greatest yields are secured where a moderate acreage is planted and the work conducted in a

most thorough manner. There is nothing technical or difficult about the growing of onions, but close attention and frequent cultivation are essential. Once the weeds get a start, the cost of production will be greatly increased, or the crop may be lost altogether.

PREPARATION OF NEW LAND.

As a general rule new land is not adapted to onion growing until it has been worked one or two years with other crops. Onions should follow some crop that has been kept under the hoe and free from weeds the previous season. Corn, beans, and potatoes are suitable crops with which to precede onions. Muck and sandy soils may in some cases be brought to a suitable condition for onions the first season, but the fitting will have to be very thoroughly performed. The land should be plowed in the autumn, then replowed in the spring, after which numerous harrowings and doubtless some hand work will be required to get the soil in suitable shape.

If necessary to manure the land heavily before planting to onions, it will be desirable to plant to some farm crop one season, then apply the manure during the autumn in order to give it time to become incorporated with the soil. Owing to the value of good onion land it would not be advisable to devote it to general farm crops for any extended period, although corn is frequently planted and oats or rye are sometimes used in the North. Cowpeas may be of great service in bringing new land into shape for planting to onions.

CROP ROTATION.

Onions should not be planted on the same piece of land year after year, and some system of crop rotation should be maintained. Care should be taken, however, to use crops in the rotation that will not be exhaustive of the high fertility necessary in the onion land. During the years when the land is not devoted to onions it can be planted to some truck crop that will give a return that will justify the application of large quantities of fertilizers, or, better, to a leguminous crop to be turned under as green manure. Continuous cropping with onions will cause the land to become infested with both disease and insect enemies that will sooner or later injure the crop to such an extent as to render it unprofitable.

PREPARATION OF THE SOIL.

Assuming that the land intended for planting to onions is capable of being brought to a good mechanical condition, fertile, well drained, and reasonably free from weed seeds, the first step in the production of the crop will be to plow moderately deep, then harrow, disk, roll, and drag until the soil is smooth and mellow to a depth of 4 or 5 inches. The method of preparing the soil will depend somewhat

upon its character, the manner of planting to be followed, and the requirements for irrigation. There are few truck or other crops that require so careful fitting of the soil as do onions, and it is essential that the fertilizers be well mixed with the soil.

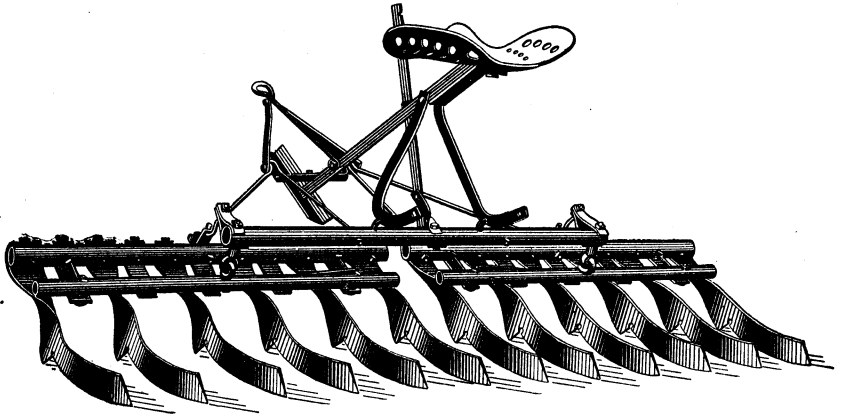


FIG. 1.—Harrow for smoothing and leveling the soil behind the plow.

On soils that are naturally well drained and where surface water can not accumulate, the plowing may be done in large blocks, but where the opposite conditions are found or irrigation is practiced it

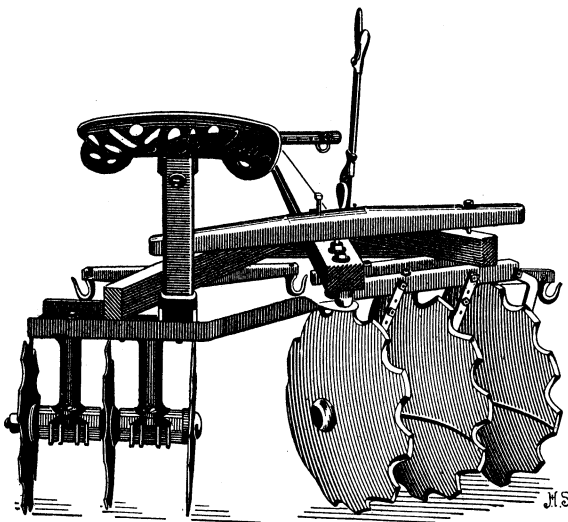


FIG. 2.—Disk plow used for refitting land.

may be necessary to plow the land in narrow beds. In the case of insufficient drainage it will be desirable to throw the soil together into beds, leaving a double furrow between each bed to carry off surplus water. Where the flooding system of irrigation is practiced the beds must be leveled and a system of ditches and ridges provided for distributing and

controlling the water. Where it is merely desired to secure surface drainage the beds may be from 75 to 150 feet in width, but for irrigation purposes the beds are generally but 12 or 15 feet in width. If

spring plowing is practiced the soil should be harrowed closely behind the plow in order to prevent drying out.

For cutting and pulverizing the soil there is perhaps no tool as serviceable as the disk harrow. There is a type of disk having four gangs, in two sets, one combination in front of the other and so arranged that the soil is first turned to the center and then turned outward again by means of the rear combination. This tool turns the soil twice and leaves it in a level condition. For smoothing and leveling the soil behind the plow a harrow of the type shown in figure 1 is very desirable; this tool not only levels but turns and crushes the soil at the same time.

On land that has been plowed during the autumn and requires replowing in the spring, a device of the type shown in figure 2 will answer and will do the work more rapidly than the plow. This tool is especially adapted to bedding up land that has been previously plowed.

For imparting the final smoothing touch to the soil before planting there is a device consisting of a large number of small disks set in a

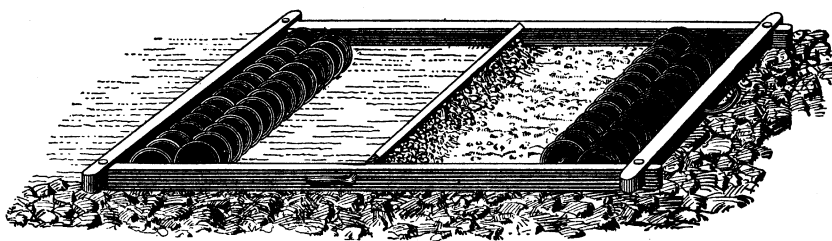


FIG. 3.—Device used for smoothing soil before seeding.

wooden frame (fig. 3) which does about the same work as a steel rake, but in a rapid manner. A drag or float made from several pieces of scantling nailed together may be used for this purpose, or if the soil is very loose a roller should be run over it. The final leveling should be performed with a tool that will fill and obliterate all tracks or other depressions in the soil, leaving a smooth, even seed bed for either seed sowing or transplanting.

FERTILIZERS.

As the onion is an intensive crop and yields great quantities of marketable bulbs for the area planted, the grower is justified in manuring heavily. It would be difficult indeed to make the soil too rich for onions provided the manures are thoroughly incorporated with the soil. A heavy application of fresh raw manure just before planting would have an injurious effect, but where the manure is well rotted and uniformly applied there is nothing to be feared.

Animal manures.—There is perhaps no fertilizer so well adapted to the production of onions as plenty of clean, well-composted stable

manure, and the quantity and frequency of application will depend upon the nature of the land under cultivation. The Bermuda-onion growers of southwestern Texas apply as high as 20 tons of sheep and goat manure to an acre every three years. In addition to the manure there is used 1,000 to 2,000 pounds of cotton-seed meal or commercial fertilizer, and sometimes a top-dressing of nitrate of soda. This sheep and goat manure is from animals that are fed largely upon cotton-seed meal, is saved in the corrals in a climate where there is very little rain, and it contains the essential fertilizing ingredients in very high percentages. The manure is first piled where a little water can be thrown over it and it is composted for several months before spreading on the land. The best results from this manure are not realized until the second or even the third year after its application.

All stable manure used on onion land should be well composted before use and then spread upon the land several months before planting to onions. In the Northern States the manure may be applied during the autumn and well disked into the soil. The land can then be allowed to lie in the rough state and exposed to the action of frost during the winter, or it can be smoothed and seeded to rye, in which case it will be necessary to replot during the early springtime. In the Bermuda district the manure should be applied during the springtime and the land kept frequently stirred during the summer months, with occasional irrigations in order to assimilate the manure and destroy weeds; the planting is not done until the autumn. Another practice in the Bermuda district is to apply fresh manure broadcast at the rate of 10 to 12 tons to the acre during the spring months, then plant to corn and cultivate through the early summer, and add a top-dressing of well-rotted manure after plowing the land for onions in the autumn. This top-dressing should be well worked into the soil by means of disk harrows. Large quantities of fresh manure applied to onion land just before planting will have a tendency to produce an overgrowth of tops at the expense of the bulbs. This is especially true on irrigated lands and soils that are naturally moist.

Commercial fertilizers.—Where there is an abundance of humus matter in the soil the onion crop will be greatly benefited by moderate applications of high-grade commercial fertilizers. A fertilizer that is suited to the growing of potatoes will serve quite well for onions, but the potash should perhaps be supplied in the form of muriate rather than of sulphate. A fertilizer adapted to the growing of onions should contain 4 to 5 per cent of nitrogen, 5 to 7 per cent of phosphoric acid, and 8 to 10 per cent of potash. A fertilizer of this character will cost \$38 to \$40 a ton and can be profitably applied at the rate of 1,000 pounds to the acre on most soils. Where very intensive culture is practiced it may be profitable to apply as much as a ton to the acre in addition to stable manure.

If it is found desirable to secure the ingredients and mix the fertilizer at home the following materials and proportions are suggested:

No. 1.—For use in the Southern States.

	Pounds.
Nitrate of soda, 14 to 16 per cent nitrogen	200
Cotton-seed meal	750
Superphosphate, 16 per cent	750
Muriate of potash, 50 per cent	300

No. 2.—For use in sections where cotton-seed meal can not readily be obtained.

	Pounds.
Nitrate of soda, 14 to 16 per cent nitrogen	300
Dried blood	500
Superphosphate	800
Muriate of potash, 50 per cent	400

No. 3.—For general use.

	Pounds.
Sulphate of ammonia, 25 per cent	200
Dried blood	300
Cotton-seed meal	300
Superphosphate	800
Muriate of potash, 50 per cent	400

The ingredients of these fertilizers should not be mixed until shortly before they are to be used, as there is danger of loss from chemical action. In mixing, the proper quantity of all ingredients should be weighed and dumped together in a heap on a clean, tight floor. The work of mixing can be done by shoveling over three or four times, but should continue until all lumps are broken and the mass has assumed a uniform color and appearance.

Commercial fertilizers should not be applied until shortly before sowing the seed and should be uniformly distributed and thoroughly worked into the soil. There are one-horse fertilizer distributors that scatter the fertilizer broadcast, but where an amount not exceeding 1,000 pounds of fertilizer to the acre is being used the work of distribution may be performed by means of a common grain drill having a fertilizer attachment. On a small scale the work is generally performed by hand.

Many growers follow the practice of applying only a part of the fertilizer at planting time, reserving the balance to be put on as a top-dressing at some time during the period of cultivation. This plan is especially desirable where onions are grown during the winter, as the application of highly nitrogenous fertilizers in the autumn is liable to promote a soft growth that will be injured by cold. If the fertilizer is not put on until cold weather is over, the crop may be forced without danger of injury. For this purpose only those fertilizers of a very available form will answer. Nitrate of soda is frequently used as a top-dressing during the height of the growing period.

PROPAGATION.

Most of the onions grown in the United States are propagated from seed. Propagation from seed is conducted by three more or less distinct methods: First, by sowing the seed in the rows where the crop is to grow and mature; second, by sowing the seed in specially prepared beds and transplanting the seedlings to the open ground; third, by first growing sets from seed and then, after keeping them through the winter, planting them in the field to produce the crop of mature bulbs. Of these three methods the one first mentioned of seeding in the rows where the crop is to mature is the only one that is practical on a very large scale. Planting sets and transplanting have their advantages, but could not be applied on a large scale owing to the amount of labor required.

Planting the seed.—In the northern onion-growing districts the seed is sown as early in the spring as the soil can be brought to the proper condition. While it is desirable to plant quite early it never pays to sow the seed before the land is in the best possible condition. When the soil has been brought to a smooth, even surface and is fine and mellow, the seed is sown by means of one of the common seed drills, of which there are several makes upon the market. The hand drills which sow one row at a time are extensively employed, but many of the larger growers employ a gang of drills hitched together and plant from five to seven rows at once. A more even distribution of the seed will be secured by the use of the single-row hand drill owing to the closer attention that can be given the one machine. The first row may be planted with a line, and after this the marker on the drill indicates the next row. The drills are so arranged that the shoe and covering blades can be regulated to cover the seed at the proper depth, which will vary with different soils. In heavy or moist soils the depth to cover the seed should not be more than one-half to three-fourths inch, while on loose and sandy soils the seed may be covered an inch or more.

Planting distances and seed required to plant an acre.—Where hand cultivation is practiced throughout, the usual distance between rows is 12 to 16 inches. Where horse culture is employed the distance between rows varies between 24 and 36 inches. The quantity of seed required to plant an acre will depend both upon the distance between rows and the purpose for which the onions are being grown. For the growing of standard market onions in rows 14 inches apart, about $4\frac{1}{2}$ pounds of first-class seed will be required. With the rows 3 feet apart, but $1\frac{1}{4}$ or $1\frac{1}{2}$ pounds will be necessary. Where it is desired to produce small onions for pickling purposes, the amount of seed may be as great as 25 pounds to an acre. Good seed is essential, and if there is any doubt regarding the vitality of the seed it should be

tested before planting by counting and planting four or five hundred seeds in a window box and then determining the germination by counting the seedlings after ten days' or two weeks' time. First-class seed is seldom sold at a low price and good seed at \$1.50 or even \$2.50 a pound may be cheaper in the end than poor seed at 50 cents. Old and inferior seeds are not only low in percentage of germination, but lack the vitality necessary to produce strong, healthy plants. There are dealers who make a specialty of securing and furnishing extra-quality onion seed, and while their prices are often somewhat above the general market the seed furnished by them is always preferable to ordinary seed.

Thinning.—Experienced growers are frequently able by using extreme care in regulating the drills to distribute onion seed in rows where the crop is to mature so that little thinning will be necessary. Thinning is generally left until the time of the first hand weeding, when all thick bunches along the rows are thinned to a uniform stand of eight or ten plants to the foot. It is always well, however, to allow for considerable loss of plants, and unless the plants are so thick as to actually crowd, thinning will not be necessary.

Transplanting method of growing onions.—The transplanting process, often spoken of as the "new onion culture," is merely a modification of the regular seeding method. The objects gained by transplanting are an earlier crop, a uniform stand, and bulbs of more regular size. Practically the entire Bermuda crop of the Southern States is handled in this manner. Where a small area is to be grown, the transplanting process is the ideal method, but for large acreages and where labor is difficult to obtain this would not be practical. After transplanting, the seedlings will require rain or watering in order that they may start, and for this reason the transplanting process is practically limited to areas where some form of irrigation is available.

In growing onions by the transplanting method the seed is sown in greenhouses, hotbeds, cold frames, or specially prepared beds at the rate of $3\frac{1}{2}$ or 4 pounds for each acre to be planted. Onion seedlings are now being grown in great quantities by southern plant growers and are shipped to northern onion growers. When the seedlings are grown under cover, they are given the necessary attention regarding watering and ventilation and kept growing quite rapidly until near the time for setting them in the open ground. As planting time approaches, the seedlings are "hardened" or prepared for transplanting by increased ventilation and exposure and by withholding water. When ready to transplant, the seedlings should be somewhat smaller than a lead pencil and rather stocky. The plants are lifted from the seed bed and the roots and tops both trimmed somewhat, as shown in figure 4. They are then packed neatly in shallow boxes for removal to the field where they are to be planted.

Various methods are employed for handling the plants in setting. As a rule, a line is used and the land marked to indicate the location of rows. Several methods are employed for marking the distance between plants in the rows; one method is by means of a line with small lead or brass indicators at regular intervals; another method is by means of a board having notches or holes in which a pointed dibble is thrust to form a hole in which to set the plant. A marking device much used by the Bermuda-onion growers in Texas consists of a sectional roller with the sections the same distance apart as the

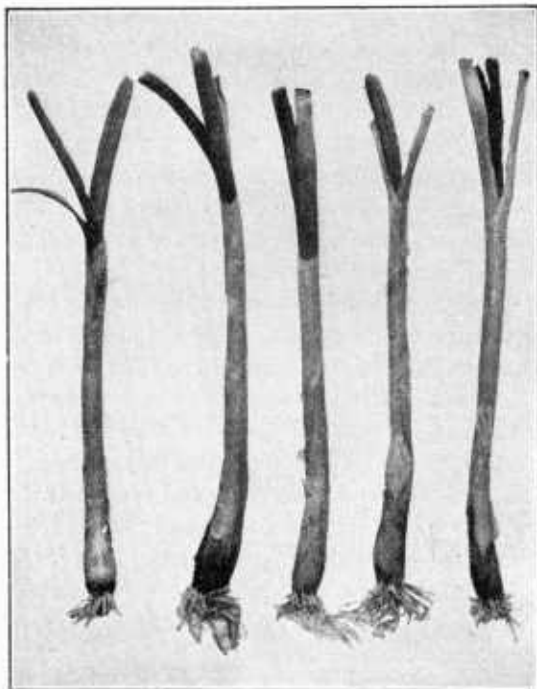


FIG. 4.—Seedling onion plants trimmed ready for transplanting.
(One-half natural size.)

distance between the rows and each section provided with conical pins to form the holes in which the plants are set. The objection to the sectional roller marker is that it can not easily be drawn in a straight line and straight rows are essential to good cultivation.

After marking the land, the plants are dropped ahead of the planters, or they may be kept in the trays and simply removed as planted. The transplanting process consists mainly in pushing the root end of the seedling into the soil with one finger and then firming the soil

about the plant. This work is very laborious and can only be performed economically by very cheap labor. A small plow, such as is generally included with the attachments of the wheel hoe (fig. 5), is often employed for opening a furrow in which to set the small onion plants. As the plants are set the soil is either drawn about them by hand, or the plow may again be used for this purpose. In the Bermuda-onion district the work of transplanting costs from \$15 to \$25 an acre and is performed by laborers who are content with 50 or 60 cents a day, boarding themselves. The work of transplanting is as a rule done by contract at about \$1.50 for each bed of one-tenth

acre. In transplanting, all inferior plants should be rejected, thus insuring a more perfect stand and development.

Propagation by sets.—The use of sets is still another modification of the regular seedling method, in which the seed is planted one year to form the sets from which to grow a crop of mature onions the following year. Like the transplanting process the use of sets is limited in its application.

Onions grown from sets will ripen earlier than those from seed sown in the field, but the use of sets for commercial onion growing is not so practical as transplanting seedlings. In planting onion sets a furrow about 2 inches deep is opened, the sets being dropped about

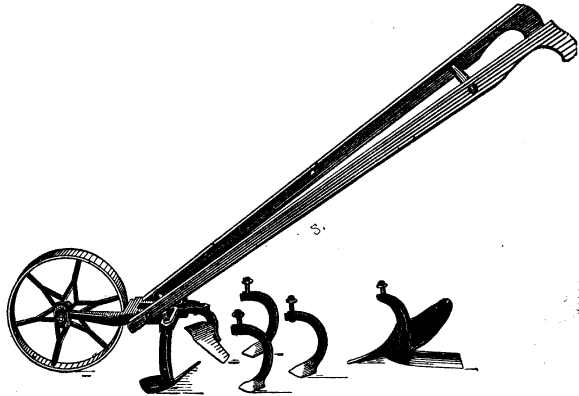


FIG. 5.—Wheel hoe adapted to working onions.

3 inches apart and firmly covered. For best results the sets should be placed in an upright position. The quantity of sets required to plant an acre will depend upon their individual size and planting distances, but it is generally between 15 and 20 bushels.

METHODS OF TILLAGE.

The cultural requirements of the onion are frequent shallow stirring of the soil and freedom from weeds. The feeding roots of the onion run close to the surface of the soil and should not be disturbed by deep cultivation. Sometimes a heavy rain immediately after seeding will so pack the surface that the seedlings can not break through. Under such circumstances it will be necessary to slightly break the surface by means of a steel rake or a rake-like attachment on a cultivator. As soon as the plants are up and the rows can be followed the cultivator should be started to loosen the soil, which is always more or less compacted during seeding.

Hand cultivation.—Where the rows are 14 inches or less apart, the work of caring for the crop must all be done by hand. For this purpose the wheel-hoe tools of various types are essential. These implements are provided with several kinds of hoes, cutters, and sweeps designed to work the soil away from the plants, to shave the

surface and destroy weeds, and to stir the soil and work it back around the plants. Onions grown on muck and alluvial soils will



FIG. 6.—Special wheel hoes for cultivating onions.

require from eight to fourteen workings with the wheel-hoe implements; on sandy soils it will not be necessary to cultivate so frequently.

Several types of wheel hoe are in use, but those having a single wheel and passing between the rows are most desirable. Those of the type in figure 5 are good. Many growers have designed special implements to suit the requirements of their soils; two of these are shown in figure 6, the one designed to cut the



FIG. 7.—High wheel type of hoe. (Patented.)

soil away from the row and the other to stir and work the soil back to the row. Some of the growers in the onion fields near Chicago have

adopted a hoe-stock consisting of a pair of light plow handles, an iron stock, and the front wheel of a bicycle. To the stock of this device may be attached almost any form of sweep or cutter, and the implement is exceptionally easy to propel. The wide distance between the handles places the implement well under the control of the operator. Figure 7 will give an idea of the general appearance of this implement.

Horse cultivation.—In sections where onions are grown on a soil that

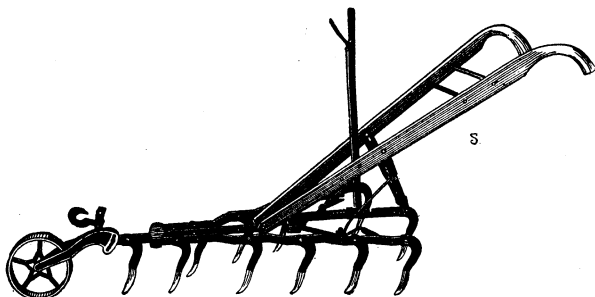


FIG. 8.—Small-tooth horse cultivator.

is not well adapted to hand culture the rows are placed 30 to 36 inches apart and the cultivation is performed by means of horse-drawn tools. This is particularly true where onions are grown on the "black waxy"

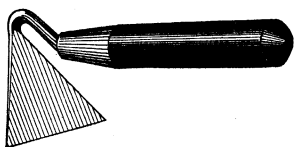


FIG. 9.—Onion hoe.

soils of Texas and other soils of the prairie type. As with hand culture, frequent shallow stirring of the soil is essential, the work generally being performed with one of the harrow-tooth cultivators. Those of the type shown in figure 8 are well adapted to this work. An implement known as a

weeder can be used for breaking the surface before the seedlings appear; also for general cultivation by removing a tooth at the point where the rows are located.

Hand weeding.—It is well-nigh impossible to produce a crop of onions without some hand weeding. During favorable seasons the strictly hand work may be reduced to but one or two weeding, but a greater number will be necessary during rainy seasons. Each

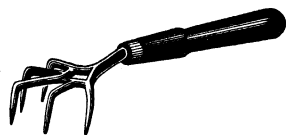


FIG. 10.—Hand weeder.

hand weeding will cost from \$5 to \$12 an acre, according to wages paid and the number of weeds present. The work of hand weeding may be facilitated by the use of some of the small hand tools designed



FIG. 11.—Thinning or weeding hook.

for the purpose. Among these tools might be mentioned the onion hoe, figure 9, the hand weeder, shown as figure 10, and the thinning or weeding hook, figure 11. Girls

and boys are expert at hand weeding, the practice being to work them in gangs of ten to twenty with an overseer behind them to see that the work is properly done. In some localities the wages paid for this class of work are as high as \$1.50 a day.

IRRIGATION.

Outside of the areas where irrigation methods are depended upon for the production of general crops it is not customary to use artificial watering in the growing of onions. In a few cases the land has been equipped with an overhead sprinkling system which is employed to moisten the soil after the seed is planted and also during extremely dry weather. On peat and muck soils the young seedlings are frequently lost by the dry muck blowing with the high winds of early springtime. In this way a part of the field may have the soil blown off to such an extent that the plants will be left without soil about them, while other portions of the field will be covered by 1 or 2 inches



FIG. 12.—Irrigation ditches in Bermuda-onion field in Texas.

of loose muck. The use of a small quantity of water sprayed over the field will prevent this shifting of the soil during a windstorm, and thus save the crop from destruction. Sandy soils are also subject to the action of winds to a greater or less extent, and losses may be prevented by the timely application of water over the surface. In a few instances subirrigation is employed in the growing of onions.

Throughout the Bermuda district of the Southwestern States surface irrigation is almost universally employed. The Bermuda onions are planted mostly in comparatively level beds with dividing ridges and are flooded once each week or ten days during the growing period. About a week before the plants are set the soil is flooded

and then worked over with disk and smoothing harrows just ahead of the planters. Within a day or two after planting the land is again flooded and the surface water drawn off; this process is repeated, with alternate cultivations, as often as the land becomes dry. Toward the end of the growing season the water is withheld to allow the bulbs to ripen. As a rule about ten waterings in all are required, at a cost of about \$1.50 an acre for each watering, or \$15 altogether. Figures 12 and 13 will give a good idea of the methods of applying the water in the Bermuda-onion-growing district.

In the principal Bermuda-onion-growing districts the water for irrigation purposes is obtained only after the expenditure of thou-

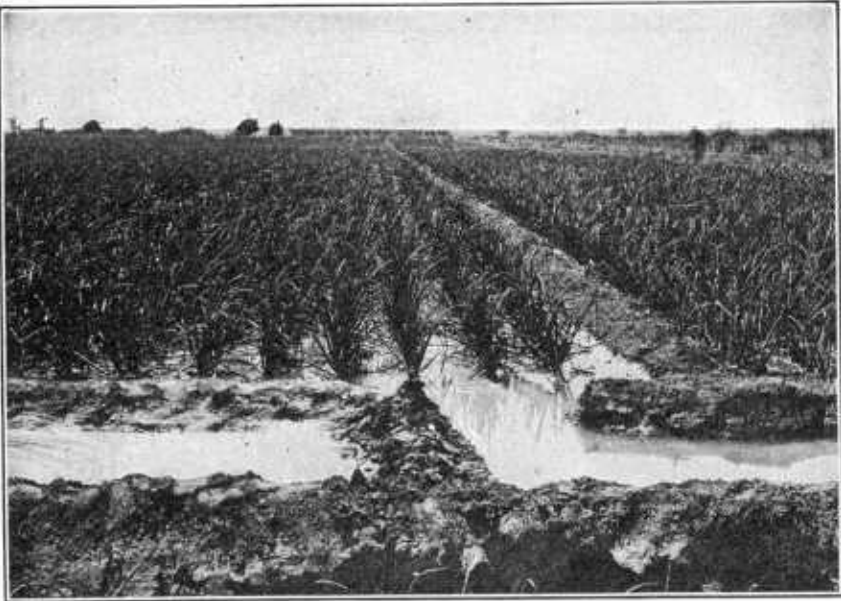


FIG. 13.—Irrigation of Bermuda onions in Texas.

sands of dollars for pipe lines and pumping machinery, and the cost of watering as given above does not include any share of the original cost for installation.

HARVESTING AND CURING.

In the northern onion districts the crop ripens and is harvested during the latter part of the summer and early autumn. As a rule the work of harvesting onions begins late in July and is practically completed and the crop housed before October first. In the Southern States, where the crop is grown during the winter, the harvesting and marketing period is during the spring months and is practically ended before the northern product comes upon the market.

Condition of bulbs when ready to harvest.—In the North the bulbs are allowed to become as ripe as possible before removing them from the soil. Growers prefer that the tops ripen down and shrivel and that the outer skin of the bulbs be dry before they are pulled. Figure 14 shows a field of onions in prime condition for gathering. To the southward, where the onions are not cured so thoroughly, they are often pulled about the time that the tops begin to break and fall. The ripening process may often be hastened by rolling a very light roller or a barrel over the tops to break them down. This process is frequently spoken of as "barreling."

Methods of handling the bulbs.—Where the bulbs are practically upon the surface they may be pulled by hand and thrown in windrows

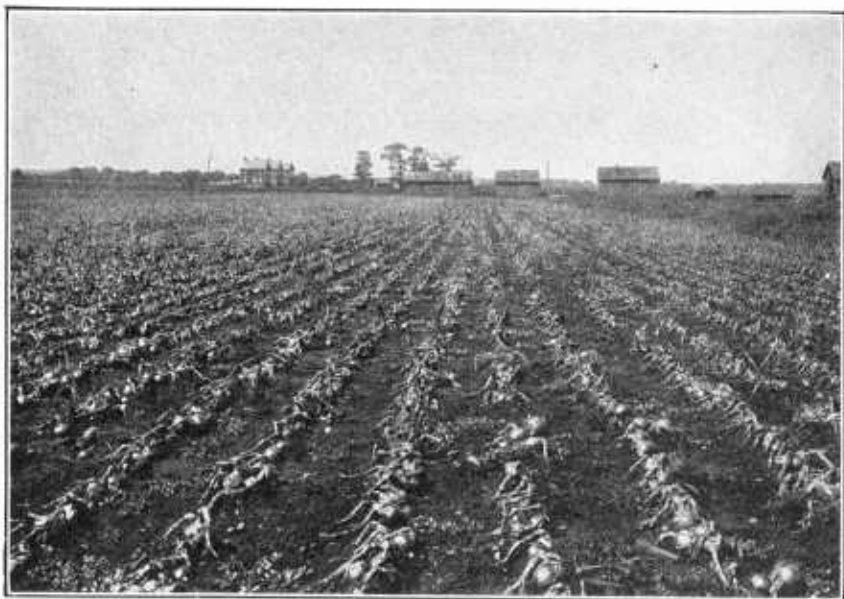


FIG. 14.—Field of onions in condition for gathering.

consisting of eight or ten onion rows. If the onion bulbs are considerably covered with soil it will be necessary to employ a one-horse plow or a cultivator with a sweep attached for lifting them. In any case it will be necessary to gather them from the soil by hand. After lying in the windrows for several days and being stirred occasionally with wooden rakes they are gone over and the tops removed either by twisting or cutting with ordinary sheep shears. In cases where very bright color is important, as with fancy White Globe onions, and this would be injured by exposure to the sun and rain, the bulbs are cured in long, narrow, low ricks formed by two

rows of onions laid with the bulbs regularly to the center, tops to the outside, the rows a few inches apart at the bottom of the rick but coming together at the top, and the top of the rick covered by straw or boards to shed the rain. As the tops are removed the bulbs are generally placed in crates for drying. In some sections onion-topping machines are employed, the bulbs being hauled from the field to a central location and run through the topper. These machines remove the tops, grade the bulbs, and deliver them into the crates or bags. If crates are not employed for curing, the bulbs are allowed to lie in the windrows for some time, and are then either put into sacks or hauled to slat cribs, where they complete the curing process. Too long exposure to hot sunshine will injure the bulbs.



FIG. 15.—Onions drying in windrows, showing crates used for curing and storing.

Figure 15 shows a field of onions drying in windrows, with crates ready for their removal from the field.

After gathering into crates the crates are either stacked in the field, hauled to a central stacking yard, where the stacks of crates are covered with boards or canvas, or hauled to open sheds and there piled one upon the other with numerous air spaces until the onions are thoroughly cured.

Where the bulbs are extremely dry at the time of their removal from the soil, they may be allowed to lie in the windrows for a few days only, and then sorted and cleaned in the field ready for packing and marketing. Where onions are put into sacks and afterwards allowed to remain in the field, the sacks should be supported on poles laid upon the ground, as shown in figure 16.

In the Bermuda-onion districts, where very little attention is given to the curing of the crop, it is the practice to pack and load into the cars as soon as possible after pulling and topping. When the shipping is at its height, it is not uncommon for onions that are pulled from the soil in the morning to be in the cars and on their way to market by evening; however, a portion of the crop is given a more thorough curing process, and the entire crop would be benefited by at least two days of curing before shipment.



FIG. 16.—Method of curing onions in sacks standing in field.

STORAGE.

In order that onions should keep well when stored they must be well ripened and thoroughly cured. Those that are immature, soft, or "thick necks" should never be placed in storage but sold as soon as gathered for whatever price they will bring. Good storage onions will rattle almost like blocks of wood when poured from one crate to another. In order that the bulbs may remain bright and of attractive appearance they should not be allowed to lie exposed to the weather, but should be hauled and stored in open sheds just as soon as they may safely be placed in one-bushel crates.

After the bulbs have remained in drying sheds or cribs for several weeks they will be ready for screening and removal to the storehouse. In handling onions it is the rule to pass them over a screen each time

they are moved, as in this way the loose skins are removed and any soft or decaying bulbs may be sorted out. When bags are used for drying in the field, the onions are screened in the manner shown in figure 17, and the bags refilled for hauling to the storage house.

In screening, the onions are placed on one end of the screen while the men stand alongside and stir the bulbs about with their hands, passing them along to the opposite end, where the bags are filled.

Conditions required in storage.—The essentials for the successful storage of onions are plenty of ventilation, storing in small quantities, a comparatively low temperature, dryness, and safety from actual



FIG. 17.—Grading onions in the field by means of a screen.

freezing. Any building wherein the above conditions may be secured will answer, but houses of the type shown in figure 18, which are built especially for the purpose, are most satisfactory.

The construction of the storage house should be double throughout, with plenty of felt or paper lining. Both top and bottom ventilation should be provided and the ventilator openings should have doors that may be closed to control the temperature. The floors are constructed of narrow planks with half-inch spaces between the planks for the passage of air. Bottom ventilation is frequently secured by means of drain pipes built into the foundation at the surface of the ground. These pipes are carried some distance toward the center

of the house and discharge the cool air at a point where it is most needed.

The temperature of the storage house should be carried as low as possible without actual freezing. During extremely cold weather the ventilator openings and doors should be kept closed to keep out cold, and after the onions have become thoroughly chilled the house should be kept closed in order to hold the temperature down and prevent the entrance of moisture during warm or rainy periods. Damp, foggy weather is injurious to onions, especially if it follows a period of cold, and will cause the bulbs to become covered with moisture if the outside air is admitted. A little artificial heat from a

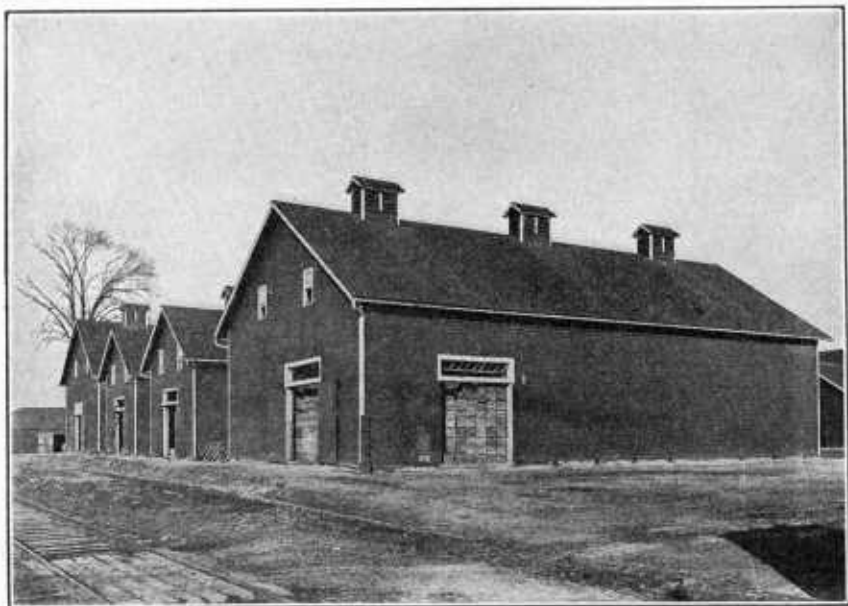


FIG. 18.—Onion storehouses.

stove or radiator may be required during excessively cold weather, but so long as the temperature in the house does not fall below 30° F. there will be no danger of injury. A temperature of 32° to 34° will give good results.

Methods of storing.—The best method of storing onions is in standard size slat crates 20 inches long, 16 inches wide, and 14 inches deep, outside measurements. The material for the sides and bottom is about $\frac{3}{8}$ inch thick and $2\frac{1}{2}$ inches wide, four pieces being used to form a side. The corners are reinforced on the inside by means of three-cornered pieces of oak, to which the slats are nailed. These dimensions provide crates that are interchangeable, the width of five being equal to the length of four. These crates will also nest together

when empty, with one inside of two turned together. The full crates are stacked in the storehouse with 1 by 3 inch strips between them to allow for the circulation of air, as shown in figure 19.

Onions are sometimes stored in slat bins holding 100 to 300 bushels each. Bags are also used to some extent, but neither bags nor bins are as satisfactory as the crates, owing to the difficulty in providing the necessary ventilation and change of air through the onions. Bulbs stored in bags or bins must be more thoroughly cured

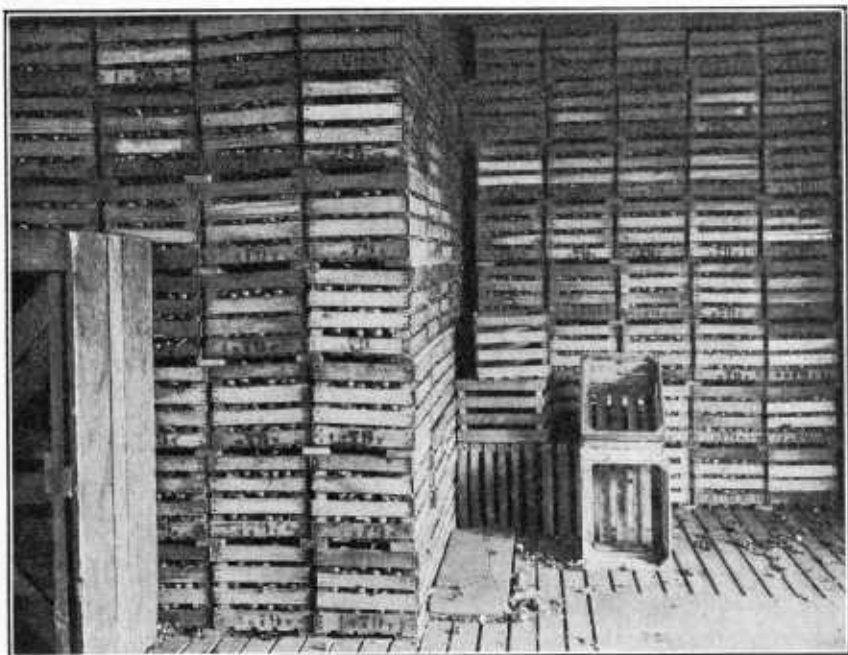


FIG. 19.—Inside of storage house, showing method of stacking crates.

than those stored in crates. There are single large storehouses in use that will accommodate 50,000 to 60,000 bushels of onions when stored in crates.

MARKETING.

Large quantities of onions are sold and shipped direct from the fields where they are grown. A part of the crop is held in temporary storage until late autumn or early winter. During recent years the winter storage of onions has become of great importance and the finest stock is held for late winter deliveries. The Bermuda crop from the southwestern part of the country comes upon the market during April and May, so that most of the storage onions are disposed of before that time.

Grading.—In marketing onions the first essential is to properly grade and clean the bulbs, in order that they may present an attractive appearance when offered for sale. Ordinarily the bulbs are separated into three grades—primes, seconds, and “picklers.” The primes include all those of $1\frac{1}{4}$ inches in diameter and larger, and the seconds consist of those from $\frac{3}{4}$ inch to $1\frac{1}{4}$ inches in diameter, while all those that will pass through a $\frac{3}{4}$ -inch screen are sold for pickling purposes. The grading is generally done in the field during the cleaning process, but as onions shrink considerably while in storage it is necessary to regrade before placing upon the market. The type of screen used for grading onions is shown in figure 20. For

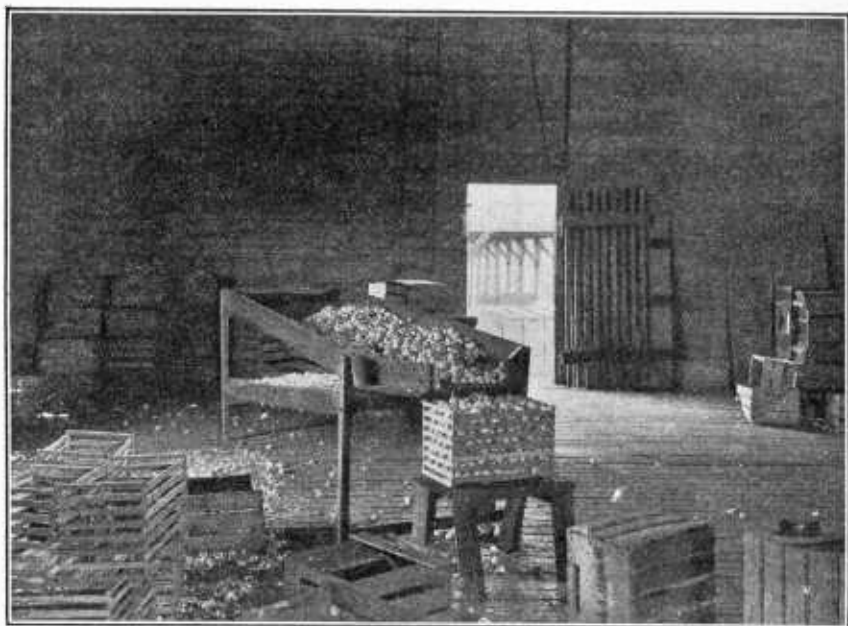


FIG. 20.—Screen used for grading and cleaning onions, showing folding crates largely used for marketing.

cleaning the pickling onions an ordinary fanning mill is employed, special screens being provided for the purpose.

Shipping packages.—Onions are placed upon the market in crates, bags, barrels, Delaware baskets, one-half barrel baskets, and in bulk. The folding crate, shown in the foreground of figure 20, is undoubtedly the most attractive package in use for marketing onions. The bags employed are of special open-mesh weave and hold 100 pounds. Onions are sometimes shipped loosely in cars and shoveled into barrels or bags at their destination.

Weight of onions.—The legal weight of onions per bushel varies somewhat in different States, but 56 pounds of dry onions are generally considered a standard bushel.

IMPORTANT COMMERCIAL VARIETIES OF ONIONS.

Common market varieties.—The varieties of onions that have distinctively yellow, white, and red skins and are of the globular type are of greatest commercial importance. Among the varieties that belong to the yellow globe class are the Prizetaker, Yellow Danvers, Yellow Globe Danvers, Southport Yellow Globe, and Ohio Yellow Globe. The principal white varieties are Southport White Globe, New Queen, Italian Tripoli, Silver Skin, and White Silver King. Among the more important red sorts are Red Globe, Red Wethersfield, and Australian Brown.

The principal Bermuda varieties are Red Bermuda, White Bermuda, and Crystal Wax. The Bermuda onions are all of the more or less flat type. The red coloration of the Bermuda onion is not distinctive like that of the Red Wethersfield or Red Globe varieties, but is lighter in color. The famous Valencia onion is of the Prizetaker type, is light yellow in color, grows to a large size, and is mild in flavor.

In the selection of varieties for any particular locality the soil conditions and market requirements should both be considered. Those adapted to the muck soils are the yellow and red sorts. For alluvial and prairie soils the red and brown varieties are to be preferred, while all kinds do well on the sandy loams and light soils. A cleaner, better grade of white onions can generally be produced on light or sandy soils than on muck or clay loams. Those of the Bermuda, Spanish, and Egyptian types flourish on the deep, rich alluvial soils of the river bottoms and delta regions.

Certain of our markets show a decided preference for onions belonging to a particular type. The red and brown varieties find ready sale on the markets of the Middle West, while onions of the yellow and white varieties are preferred in the eastern cities. Onions will withstand long-distance shipment, those of the Red Globe type being generally more subject to injury than the yellow and brown sorts. Some of the white varieties also have a thin skin and are easily injured. It should be the aim of every grower to employ varieties that will withstand handling and at the same time find ready sale on the market.

Other types of onions.—Among the types not already discussed are top onions, multipliers, garlic, and leeks, which are planted to some extent for marketing purposes.

The top or tree onion, which reproduces by means of small bulb-lets formed on the top of a seed stalk, is extensively used in the production of early spring bunching onions.

The multiplier or potato onion reproduces by a division of the bulbs. In growing this variety it is necessary to plant large bulbs to produce sets for the next year's planting and small bulbs or sets for the crop of large onions. The bulbs of this variety may remain in the soil year after year and are desirable for use early in the springtime.

Garlic is closely allied to the onion, but will remain in the ground from one year to another if undisturbed. Garlic is planted by setting the small bulbs, or cloves, in either the autumn or early spring. The culture is practically the same as for the onion.

The leek also belongs to the same class as does the onion, but requires somewhat different treatment. The seed is usually sown in a trench and the plants thinned to about 4 inches in the row. The plants of the leek are given about the same cultivation as onions, except that after they have attained almost full size the soil is drawn around them to a height of 6 or 8 inches to blanch the fleshy stem. The leek does not form a true bulb like the onion, but the stem is uniformly thick throughout. Leeks are marketed in bunches, like young onions, and they may be stored in cellars for winter use.

THE PRODUCTION OF BERMUDA ONIONS.

Bermuda onions are now an important commercial crop in Texas, California, and Louisiana, with small plantings in a number of the Southern States. The Bermuda onion fields of Texas are located around Laredo and other points in the Rio Grande valley. In 1926 Texas shipped 4,032 carloads from 12,510 acres, California 1,790 carloads from 2,750 acres, and Louisiana 588 carloads from 2,300 acres.

SOILS AND CLIMATE ADAPTED TO THE BERMUDA ONION.

Soils of a silty or alluvial nature are suited to the production of Bermuda onions, and those containing considerable sand are most desirable. As already noted in referring to fertilizers for onions, the Bermuda requires a very rich soil for the best results, and this can only be obtained by first selecting a good soil and then manuring heavily. The Bermuda onion as grown in this country is a winter crop; therefore, mild climatic conditions are required. While the plants would withstand considerable freezing, their growth is seriously checked by cold weather, and the crop will not mature in time for the early market if grown to the northward.

CULTURAL METHODS.

The cultural methods employed in the growing of Bermuda onions are essentially the same as those for ordinary onions. As the greater portion of the crop is grown in a region which has no regular rainfall, irrigation methods are employed almost universally. The greater part of the crop is grown by the transplanting process and a great amount of hand labor is required. The seeds are sown in specially prepared outdoor beds from the middle of September to the middle of October, and the seedlings are transplanted to the field November 20 to January 10, or even later. Three and one-half to four and one-half pounds of seed are required for each acre to be planted; this will allow for discarding all the weaker plants. The plants are allowed to remain in the seed bed until they are from $\frac{3}{8}$ to $\frac{1}{2}$ inch in diameter before they are transplanted. As the seedlings are lifted the greater portion of both the small roots and the tops is trimmed off in order that they may be transplanted more readily. (See fig. 4.)

HARVESTING AND MARKETING.

Bermuda onions are harvested as early as possible, generally before the tops have become fully ripened. For removing the bulbs from the ground a 1-horse plow, a potato digger, or a cultivator with a cutter wing attached is employed. The bulbs are then separated from the soil by hand, the tops cut off with shears, and the onions thrown in windrows or piles to dry in practically the same manner as for the regular-crop onions in the North. After the bulbs have become thoroughly dry on the surface they are either placed directly in the crates for shipment or are carried to a packing shed to be graded and packed for market.

During the early days of the Bermuda-onion industry the crop was shipped largely in bags, but it was soon found that the bulbs were too perishable for this method of handling. At present the greater portion of the crop is sent to market in folding slat crates that are about 20 inches long, 12 inches wide, and 12 inches high.

These crates hold approximately 50 pounds of onions and weigh 56 or 57 pounds when filled. The cost of these crates is about \$18 a hundred, but they add enough to the attractiveness and carrying qualities of the onions to make their use profitable.

YIELD OF BERMUDA ONIONS AND PRICES OBTAINED.

Phenomenal yields of 34,000 and 35,000 pounds of Bermuda onions are frequently made on an acre of land, but this is far above the general average, which is in the neighborhood of 10,000 or 12,000 pounds to the acre. Many fields, especially when planted for the

first time, do not yield as much as 10,000 pounds to the acre. On land that has been heavily manured and planted to onions for several years the yield averages about 16,000 pounds.

The prices paid the growers vary according to the market and condition of the crop, but are generally about \$1.60 a hundredweight, the buyer furnishing the crates and loading the cars. With a normal yield of 16,000 pounds the returns would at this rate be about \$250 an acre.

In figuring cost of production the following items should be included: Interest on investment in land and equipment; depreciation of equipment; preparation of land; manure and fertilizers; cost of seed; cost of growing the plants; transplanting from plant bed to field; cultivation and hand weeding; irrigation; harvesting, drying, and preparing onions for market.

The best Bermuda-onion farms are valued at \$300 to \$500 an acre. In order to prove profitable, the growing of Bermuda onions should be conducted on a comparatively large scale. The necessary land and irrigation facilities will require the initial outlay of from \$10,000 to \$30,000, and the running expenses are quite heavy. Labor can be secured at a low price, but is correspondingly inefficient and often not to be had in sufficient quantities. Furthermore, the markets are now pretty well supplied with Bermuda onions, and persons who desire to engage in their production are advised to investigate every phase of the industry before embarking too heavily in it. The expansion of the Bermuda-onion industry is limited by the facts that a large supply of bulbs can be grown on a comparatively small area, that the distance to market is great, that the product is perishable, and that the markets will consume only a limited quantity at the prices at which the crop can be sold with profit.

GREEN ONIONS FOR BUNCHING.

Another phase of onion culture that is of considerable importance in certain localities is the production of young bunching onions for the early spring trade. In several sections along the South Atlantic coast the growing of this class of onions is quite an enterprise. Many persons who are engaged in other lines of work follow the practice of growing a small area of bunching onions as a side issue.

TYPE OF ONIONS EMPLOYED.

The varieties known as multipliers and top onions are generally employed for this purpose; however, bunching onions are sometimes grown from ordinary sets, from inferior and damaged large onions, and from seed. The multipliers and top onions are the only kinds adapted for this work on a large scale.

CULTURAL METHODS.

For growing bunching onions the bulbs or sets are planted during the autumn either in beds or in rows 12 or 14 inches apart with the bulbs quite close in the rows. The bulbs will start growing within a short time and make more or less growth during the winter. As soon as the weather becomes warm during the first months of spring the onions make a rapid growth and are ready for marketing about the time peach trees begin to bloom.

The land upon which these onions are grown should be rich and mellow, but very little actual cultivation will be required. Where the winters are severe it may be necessary to provide slight protection, either a little straw, loose manure, leaves, pine straw, or corn fodder that has been run through a shredder. If the onion beds are protected on the exposed sides by means of a wind-break consisting of a grove of pines, a fence of boards, pine boughs, or corn fodder, the crop will be ready for marketing a little earlier than if left exposed. The onions not gathered for marketing are allowed to remain to form the bulbs for planting the following season.

MARKETING.

In marketing this class of onions the young shoots are pulled, the roots trimmed, and the outside peeled off, leaving the stem white and clean. The onions are then tied in small bunches by means of a soft white string, the tops trimmed slightly, and the bunches packed in crates or baskets for shipment or sale on the local market. This phase of the onion industry is limited to small plantings and is well suited to the needs of the general market garden.

During the springtime and early summer large quantities of ordinary young onions are pulled when the bulb is about the size of a fifty-cent piece, the roots and tops are trimmed, and they are then bunched and sold for stewing purposes. So far as known, this class of onions is not shipped to any great extent, but is sold mainly on local markets.

ENEMIES OF THE ONION.

The onion crop of the United States is by no means free from both disease and insect enemies. For information regarding them and measures of control, the reader is referred to the following publications which may be obtained on application to the United States Department of Agriculture, Washington, D. C.:

Farmers' Bulletin 1060, Onion Diseases and Their Control.

Farmers' Bulletin 1371, Diseases and Insects of Garden Vegetables.

SUMMARY.

Onions are one of the most common garden crops and are adapted for planting under a wide range of soil and climatic conditions. The intensive type of culture employed in producing onions makes the crop one of the best for growing in small patches and in home gardens.

Commercial onion culture is also profitable on a large scale where soil, climatic, and marketing conditions are suitable. Many of the large muck-soil deposits of the Northeastern States, especially in the region adjacent to the Great Lakes, are well adapted for the commercial growing of onions. The loamy soils of the Connecticut River valley are also well suited for growing the crop.

Owing to variations in the cost of labor, tools, fertilizers, seed, and other materials and the many factors involved in the production of an onion crop it is impossible to give definite cost and profit figures. The average yield of onions is around 290 bushels to the acre, but yields of 400 to 600 bushels are not uncommon. The price of onions is extremely variable one year with another, but on the whole the crop has proved profitable to the growers when taken on an average for a period of years.

In some sections onions are grown in rows 3 feet apart and given horse cultivation, thus reducing the yield to about 150 bushels on an acre and cutting down production costs in proportion. This method of growing onions is especially adapted for use on low-priced land and where hand labor is scarce.

PRESENT RELATION BETWEEN SUPPLY AND DEMAND.

Both the supply and the demand for onions are increasing and at present bear about an equal relation to each other. Some years the supply falls a little short and the prices go somewhat higher, with the result that larger quantities are imported. The following season the plantings are generally heavier, the market may be a little slow, and the result will be low prices and a great many people will discontinue the growing of onions.

Prices of onions, especially the Texas-grown Bermuda onions, are greatly influenced by importations of Egyptian onions which appear on our markets about the same time of the year that the Bermuda onions are being marketed. The ease with which both the Egyptian and the Spanish onions can be delivered to our eastern markets as compared with the long freight haul from southwestern Texas or Pacific Coast States renders the position of the American Bermuda onion grower more or less hazardous. Despite this condition, however, both the Bermuda and the Spanish onion industries have become well established in the United States. The American grower of Bermuda onions is still dependent upon the Teneriffe Islands for his seed supply. In the case of the Valencia or Spanish onion, a part of the crop is grown from imported seed, but American seedsmen are now providing the remainder of the seed supply.